Microfocus X-Ray CT System

inspeXio SMX-225CT FPD HR Plus
Advanced Operability and Excellent Image Quality That Overturns Conventional Assumptions

inspeXio SMX-225CT FPD HR Plus
Microfocus X-Ray CT System

The inspeXio SMX-225CT FPD HR Plus is a high-performance microfocus X-ray CT system equipped with a Shimadzu microfocus X-ray generator and a large high-resolution flat panel detector. The large detection area, input resolution equivalent to 14 megapixels, and an enhanced high-output microfocus X-ray generator enable CT images with a large field-of-view, high resolution, and high contrast. In addition, the improved HPCinspeXio high-performance computing system processes images faster. These developments make the inspeXio SMX-225CT FPD HR Plus system applicable for researching, developing, or inspecting a wide variety of samples, from composite materials, such as glass fiber reinforced plastic (GFRP) and continuous fiber reinforced thermoplastic laminate (CFRTP) materials to large aluminum die cast parts.
High-Resolution CT Imaging

The large high-resolution flat panel detector has an input resolution equivalent to 14 megapixels, which provides a large field-of-view and high resolution.

High-Contrast CT Imaging

Improvements to the Shimadzu-made microfocus X-ray generator and the sensitivity characteristics of the state-of-the-art flat panel detector enable unprecedented high output and image contrast.

Easy and Fast CT Scanning

In addition to the automated CT scanning function, which relieves the operator from having to specify parameter settings, the system also includes an improved version of the HPInspeXio ver. 3.0 high-performance computing system, providing 50 times faster processing speeds.
High-Resolution CT Imaging

Maximum 14 Megapixel Input Resolution

The large high-resolution flat panel detector achieves an offset scan input resolution of up to 14 megapixels.

Supporting cone-beam CT reconstruction with an ultra-high resolution of 4,096 × 4,096 pixels, the system can fully utilize the performance of the high-resolution X-ray detector.
High-Contrast CT Imaging

High-Contrast Detector with Wide Dynamic Range

Cesium iodide (CsI), which has excellent sensitivity characteristics in the long wavelength region, is employed as the scintillator material. The use of carbon (C) for the detector window material enables imaging on low-density materials. Furthermore, the wide dynamic range (16-bits) enables small contrast differences to be displayed.

Improved X-Ray Generator

The Shimadzu-made microfocus X-ray generator unit now includes a newly developed irradiation window. Due to the larger proportion of soft X-rays in the X-ray output, it offers significantly improved contrast when scanning low-density materials that easily transmit X-rays. In addition, the irradiation angle has been optimized for the wide field flat panel detector.

Comparison of Cross-Sectional Images from Non-Woven Fabric

Previous Image

New System Image
Easy and Fast CT Scanning

Intuitive User Interface

The new user interface features a simpler arrangement for intuitive operation.

Main System Window Displays the stage position, scan field of view, equivalent voxel length, and other information in real time (the yellow box), making it easy to scan images with the specified resolution and field-of-view size.

MPR Window Displays slice, oblique, and double-oblique images, enabling the easy observation of cross-sections.

Automated CT Scanning Function

The new automated CT scanning function enables scan parameters to be specified easily. Simply select the material, the desired CT image resolution, and the contrast level, and the system automatically optimizes the CT scanning parameter settings accordingly.
HPCinspeXio High-Performance Computing System ver. 3.0

The HPCinspeXio high-performance computing system is around 50 times faster* than the previous version.

* When the fast acquisition mode is configured and the CT slice size is set to 1,024 × 1,024 pixels

Even Faster 2,048 × 2,048 Pixel Cone-Beam CT Reconstruction

The high-performance computing system is updated. The processing time for 2,048 × 2,048 pixels Cone-Beam CT reconstruction* is around 1.5 times faster than the previous version.

* Setting conditions: "Clear", 1200 View, full scan, AUTO scaling factor, reconfiguration (2,048 × 2,048 pixels)
Easy and Fast CT Scanning

Obtain CT Images in Three Easy Steps

No calibration process is necessary before scanning. Scans can be started immediately after sample placement.

**step 1**
Place the sample.
Maximum sample and CT scan size are 400 mm in diameter and 300 mm in height.

**step 2**
Determine the scan position.
Samples are positioned using the camera mounted on the rotation axis.

**step 3**
Start the scan.
Scans can be started immediately without prior calibration.
In normal scan (600 View), data acquisition can be done in as short as 33 seconds.
Due to the high-performance computing system, MPR images are displayed 5 to 10 seconds after scanning is finished.
3D CT Scan Region Display Function

As the CT stage moves, the corresponding CT scan region is displayed and overlaid in real-time on the MPR display. Based on the previous CT scan image, additional CT scans for areas of interest can be obtained.

To magnify this area

Click in the 3D FOV control buttons.

The scan region is updated as the CT stage moves.

Start the scan. The magnified scan image is obtained.
Easy and Fast CT Scanning

Advanced 3D image Reconstruction  New!!

It is possible to enlarge only the focused areas in images once acquired and perform the reconstruction calculation. High-magnification cross-sectional images can be obtained even in the works that enlargement ratio is difficult to be improved. Equipped with a high-resolution flat panel detector, clear cross-sectional images can be obtained even when performing reconstruction. It is not necessary to perform the CT scanning once again when performing reconstruction only.

Both reconstruction calculation time and data capacity can be reduced.

Unique Functions

◆ Extended Filament Lifetime  New!!
The expected lifetime of filament is extended by 2.5 times by automatically adjusting the current value.

◆ Acquisition Mode Switching Function
Long or short scan times can be specified by combining acquisition mode and exposure time settings.

◆ Anti-Pinch Prevention Mechanism
A finger-pinch prevention mechanism is provided to prevent accidents when closing the sliding door.

◆ Door Interlock Mechanisms
The sliding door is equipped with redundant interlock circuits. These ensure X-rays are never emitted when the sliding door is open. In addition, these stop the CT stage from moving when the sliding door is open.

◆ CR Scan
Computed radiography (CR) can be used to obtain transmission images without distortion in the CT-Z direction by acquiring data only along the vertical center line of the X-ray detector while moving the CT-Z axis vertically.

◆ DICOM Conversion Function
CT image data can be converted to the DICOM format, which is the world standard for medical imaging. Consequently, this function is essential for analyzing data with medical image analysis software.

- This feature is not guaranteed to function properly with all DICOM compatible software.
- CT image brightness values are indicated in 16-bit grayscale, which do not match Hounsfield values. A function is provided for converting CT image brightness values via manual input.

◆ Collision Sensor
Collision sensors are provided around the X-ray tube to stop the CT stage in the event of an emergency (a collision with the sample). The collision sensor window can be opened or closed depending on the magnification rate.
Principle and Function

System Configuration and Operating Principle

The inspection target (sample) is placed between the X-ray generator and detector, as shown below. Then, the sample is rotated 360 degrees to collect X-ray fluoroscopic data from various angles in order to calculate cross-sectional images.

MPR Display
(Displays any cross section desired)
Multi Planar Reconstruction (MPR) stacks multiple CT images in a virtual space to display four images—a CT image, mutually longitudinal section images, and a user-selected section image orthogonal to one of the longitudinal section images.

VR Display
Volume rendering (VR) stacks multiple CT images in a virtual space to display a 3D image. Separate 3D image processing software is required for VR display.
Optional Software

Metal Artifact Reduction Software

The Metal Artifact Reduction Software is a reconstruction software program used to reduce metal artifacts in the cross-sectional images acquired using Shimadzu’s micro-focus X-ray computed tomography system, inspeXio SMX-225CT FPD HR Plus. This software allows for easier and more accurate analyses in the cross-sectional images.

10-pin connector before processing

10-pin connector after processing

Photosensor before processing

(Top: VR image, bottom: STL)

Photosensor after processing

(Top: VR image, bottom: STL)
HADI-S  
2D Image Processing Software

This two dimensional image processing software enables sophisticated image processing. Various image processing such as dimension measurement and filtering is possible for transmission images and cross-sectional images.

VGStudio MAX  
3D Image Processing Software

This is an extended version of VGStudio. Extended functionality includes animation creation (rotation, truncating, and viewpoint movement), measurement of length, angle, minimum distance, histogram, volume, surface area, void ratio, ROI extraction, image filtering, and multiple 3D image alignment.

POLYGONALmeister®

Polygon editing software

POLYGONALmeister is a polygon editing software which solves various problems such as noise and artifacts with polygon data produced by measuring the surface of objects, and reduces data size. It is effective when using measurement data in design / analysis / 3D printing etc.

The results of the integrated research program with RIKEN are utilized.

inspeXio SMX-225CT FPD HR Plus
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**Applications**

**Aluminum Die Castings**

By scanning the die cast part before machining and then specifying the surface after machining (CAD data), the software can determine which voids are removed by machining, which remain internally, and which are exposed on the surface after machining.

- **Voids that are removed**
- **Internal voids**
- **Voids exposed on the surface**

By specifying the void cross section and surface, the software can also 3D CAD void determination. Blue line: CAD data analysis after machining.
GFRP (Glass Fiber Reinforced Plastic)

Cross-section Image FOV = ø20 mm

VR Image

Defect Analysis

Defect Analysis Histogram

Fiber Orientation Analysis

Fiber orientation analysis can display a color-coded map of filler orientation. Needles can also be displayed based on the orientation.
CFRTP (Continuous Fiber Reinforced Thermoplastic Laminate)

MPR Image FOV = ø3.9 mm
Oblique Image
Defect Analysis

VR Image
Fiber Orientation Analysis
Provided by Ehime University

BGA (Ball Grid Array)

MPR Image FOV = ø5 mm
VR Image

Concrete

MPR Image FOV = ø42 mm
VR Image
Void Analysis
Provided by Emeritus Professor Moriyoshi at Hokkaido University
Product Verification Example

Analysis Using PointMaster Reverse Engineering Software

The software can align CT data with 3D-CAD data, calculate the distance between the boundary surface defined in the CT data and the corresponding 3D-CAD data, and display a color-coded map based on such differences.

Remove plastic case only
CT scan

Align positions
VR
CAD

Render volume

Shape Comparison
Results from shape comparison analysis

Wall Thickness Measurement
Results from thickness analysis

Difference 2 (mm) : -0.0081
Difference 3 (mm) : 0.1423
Difference 1 (mm) : 0.3393

Thickness 3 (mm) : 2.5441
Thickness 1 (mm) : 2.7779
Thickness 2 (mm) : 1.6991

Dimension (mm²)

Difference (mm)

Dimension (mm²)

Thickness (mm)
## Specifications

<table>
<thead>
<tr>
<th>inspeXio SMX-225CT Series</th>
<th>inspeXio SMX-225CT FPD HR</th>
<th>inspeXio SMX-225CT FPD</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Model</strong></td>
<td>inspeXio SMX-225CT FPD HR</td>
<td>inspeXio SMX-225CT FPD</td>
</tr>
<tr>
<td>P/N</td>
<td>362-84550</td>
<td>362-84850</td>
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<tr>
<td><strong>X-Ray Generator</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rated Power</td>
<td>135 W</td>
<td>135 W</td>
</tr>
<tr>
<td>Max. Tube Voltage</td>
<td>225 kV</td>
<td>225 kV</td>
</tr>
<tr>
<td>Max. Tube Current</td>
<td>1000 µA</td>
<td>1000 µA</td>
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<tr>
<td><strong>X-Ray Detector</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Size</td>
<td>16 inch</td>
<td>8 inch</td>
</tr>
<tr>
<td>Shades of Gray</td>
<td>16-bit = 65,536 shades of gray</td>
<td>14-bit = 16,384 shades of gray</td>
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<tr>
<td>Max. Input Resolution (for offset scan)</td>
<td>Approx. 14,000,000 pixels</td>
<td>Approx. 1,800,000 pixels</td>
</tr>
<tr>
<td><strong>Max. Sample Size and Weight, and Max. CT-Scan Region</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Max. CT Image Size</td>
<td>Two-Dimensional CT</td>
<td>Two-Dimensional CT</td>
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<tr>
<td>Cone-Beam CT</td>
<td>4,096 × 4,096</td>
<td>2,048 × 2,048</td>
</tr>
<tr>
<td><strong>High-Performance Computing System</strong></td>
<td></td>
<td></td>
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<tr>
<td>Version</td>
<td>HPCinspeXio ver. 3.0</td>
<td>HPCinspeXio</td>
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<tr>
<td><strong>Scan Support Functions</strong></td>
<td></td>
<td></td>
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<tr>
<td>Positioning via an exterior camera</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>3D CT Scan Region Display Function</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Fully Automatic CT Scanning</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td><strong>CT Stage Max. Stroke</strong></td>
<td>SRD Axis²⁺</td>
<td>SDD Axis²⁺</td>
</tr>
<tr>
<td></td>
<td>890 mm</td>
<td>690 mm</td>
</tr>
<tr>
<td><strong>CT-Z Axis</strong></td>
<td>Switchable between 2 levels (800, 1200)</td>
<td>Switchable between 4 levels (400, 600, 800, 1000)</td>
</tr>
<tr>
<td><strong>Scan Modes</strong></td>
<td>Normal scan, half scan, offset scan, FS scan²⁺, 2DCT²⁺, CBCT²⁺</td>
<td>Normal scan, half scan, offset scan, FS scan²⁺, 2DCT²⁺, CBCT²⁺</td>
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<tr>
<td>CT Data Acquisition Time</td>
<td>Any value from 10 sec to 60 min</td>
<td>Any value from 10 sec to 30 min</td>
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<tr>
<td><strong>Shield Box Size and Mass</strong></td>
<td>W2,170 × D1,350 × H1,857 mm, approx. 3,100 kg</td>
<td>W1,200 × D700 × H1,270 mm, approx. 60 kg</td>
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<tr>
<td><strong>Power Requirements</strong></td>
<td>Main Unit</td>
<td>Control Computer</td>
</tr>
<tr>
<td></td>
<td>200 V AC ±10 %, 50/60 Hz, 3 kVA</td>
<td>100 V AC ±10 %, 50/60 Hz, 1 kVA</td>
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<tr>
<td>Ground</td>
<td>Type-D ground (100 ohm max. ground resistance)</td>
<td>Type-D ground (100 ohm max. ground resistance)</td>
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<tr>
<td><strong>External Leakage Dose</strong></td>
<td>1 µSv/h max.</td>
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</tbody>
</table>

*Model “inspeXio SMX-225CT FPD HR” of this equipment includes “Plus” as a sub name for models equipped with CT control software inspeXio64 ver. 3.0.

¹ SRD axis: The source-to-rotation center distance (SRD) is the distance from the X-ray source to the rotation center of the sample.

² SDD axis: The source-to-detector distance (SDD) is the distance from the X-ray source to the X-ray detector.

³ FS scan: The fan-shaped (FS) scan obtains CT images by scanning the sample at 60, 90, and 120 degree rotation angles.

⁴ 2DCT: Two-dimensional computed tomography (2DCT) obtains one or three CT images from each CT scan.

⁵ CBCT: Cone beam computed tomography (CBCT) obtains several hundred CT images from each CT scan.
InspeXio SMX-225CT FPD HR Plus

Layout and Dimensional Drawings

(Recommended installation area: W3,700 × D3,000)

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